

## **Plateuing Coincidences**

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### **Materials:**

- Beta, Delta, Mu, and Theta base
- Scintillators A, C and B
- LBB (Little Black Box), channels A and C
- multimeter
- 18 volt transformer
- 5 volt transformer
- Qnet board and all of its supplies, such as serial cables, etc.
- HyperTerminal or Z-Tech
- Excel
- A PC or a Mac equipped with a RS-232 port or RS-232 to USB2 adapter

### **Objective:**

To plateau one base at a time, while another remains at one constant voltage. Also, using coincidence rates for plateauing and study the performance of each base by observing the single's rate.

### **Procedure:**

1. Set all of the discriminators to a threshold of .3 volts.
2. Set parameters on the Qnet board, using Hyper Terminal.
  - a. Type "WT 00 00" into HyperTerminal and press enter. This is the leading edge of coincidence window.
  - b. Type "WT 00 02" into HyperTerminal and press enter. This is the trailing edge of the coincidence window.
  - c. Type "WC 00 13" into HyperTerminal and press enter. This establishes two-fold coincidence setting
  - d. Type "WC 00 1F" into HyperTerminal and press enter.
  - e. Type "WC 03 00" into HyperTerminal and press enter.
  - f. Type "SA 1" into HyperTerminal and press enter. This saves the previously mentioned settings.
3. Set voltage on the control base so that 100 hertz of counts comes through the DAQ board.

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4. Find the singles and coincidence counts by using HyperTerminal every five minutes. Start with voltages between 0.8 – 1 volts, with 0.02 increments. In other words, for voltages 0.8, 0.82, 0.84, 0.86, 0.88, 0.9, 0.92, 0.94, 0.96, 0.98, and 1. How?
  - a. Type “RB” into HyperTerminal. This resets the TMC, or counter.
  - b. Start a timer for five minutes at the same time you start the TMC.
  - c. Once five minutes have passed, type “DS” into HyperTerminal. This displays the “scalars”, aka: the singles and coincidence counts.
  - d. S0 = single’s rate for channel 0, S1 = single’s rate for channel 1, S2 = single’s rate for channel 2, and S4 = the coincidence rate for channels 0 and 1. HyperTerminal displays a series of numbers and letters in hexadecimal that translate to a specific number.

### **Use Excel to create a Graph and Data Table:**

Creating a Data Table:

1. Open Excel
2. While plateauing, document data, such as the base and discriminator voltages, time collecting data at each voltage, and intervals between varied voltage
3. Create columns for “Voltage”, “Counts”, “Rate (Hz)”, and “Error” in Excel
  - a. Under “Voltage”, write each variant voltage used for taking counts. This will be your x-value on the graph you create to find the plateau.
  - b. If data is being taken directly from HyperTerminal, it will be useful to convert hex into decimal in the counts column. To do this the boxes under “Counts” will need an equation.
    - i. To enter an equation, click on the cell under “Counts” and type “=”.
    - ii. Type “HEX2DEC(“”)” HEX, for hex, and DEC, for decimal, 2, for the conversion from one to the other, and inside the parenthetical quotations goes the number in hex.

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- c. The count rate can be measured in Hertz, or counts per second. By entering an equation, the "Rate" column will automatically process data.
    - i. Click on the cell under "Rate" and type "=".
    - ii. Then, click on the cell across from in under the "Counts" column. A colored letter-number combination will appear, labeling the cell you clicked on. The letter labels the column you are under, and the number labels the row you are across from, ex: C15.
    - iii. In the same cell, type in "/" and the number of seconds you took data for. This equation tells the program to divide the number in the "Counts" column by the seconds and will yield Hertz.
  - d. Error is calculated by dividing the rate by the square root of the number of counts. Type "=" in a cell under the column marked "Error" and then select the cell across from it in the "Rate" column. Type "/SQRT()" into the cell. This divides everything in the rate column by the square root of any value in the parenthesis. As you take data, enter the corresponding cell in the Counts column in the parenthesis.
4. Click the right hand corner of a selected cell and drag down.

### **Creating a Graph:**

1. At the top bar, go to "Insert" and click "Chart". A wizard will appear
2. Select the XY (Scatter) option and press "Next"
3. Select the tab labeled "Series" to enter the columns for the x and y values.
4. Click the colored button next to "X Values" and select the desired cells for your x-values. In this case, it is under the "voltage" column. Press enter.
5. Click the colored button next to "Y Values" and select the desired cells for your y-values. In this case, it is under the "Rate" or "Counts" column. Press enter.
6. Remove any other series.
7. Click on "next" and add titles for the graph and axes.

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8. Use the other tabs to select desired effect. (For this graph we turned off gridlines and legend.) Then press “Next.”
9. Select as an object in your current sheet and press “Finish.”
10. Add error bars:
  - a. Double-click a series point.
  - b. Select the “Y Error Bars” tab.
  - c. Click the colored button next to the + sign under “Custom” and select the cells in the column marked Error. Do the same for the – sign and press “OK”
  - d. This is where entering a temporary 1 in the Counts column was important. Without that, the “Error” column would be dividing by zero, making each value undefined.
11. To change the X axis scale double click on a number on the scale.
12. To change the color of the graph background, double click on the background.

**Hypothesis:**

According to the data taken in a previous experiment, the plateau is probably around 0.95 volts, and no greater than 1 volt.

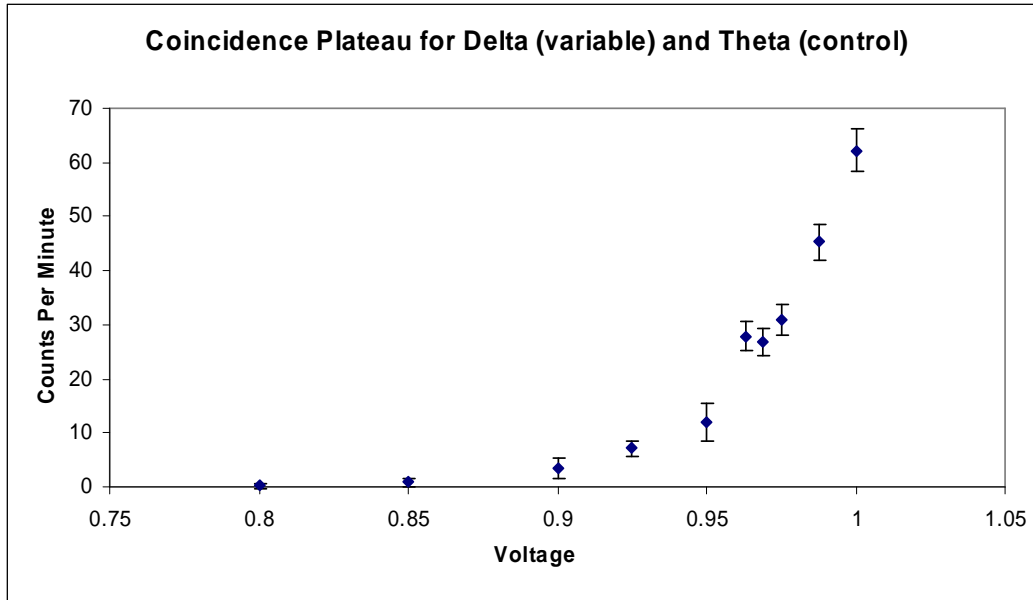
**Graphs:**

**Delta Plateau:**

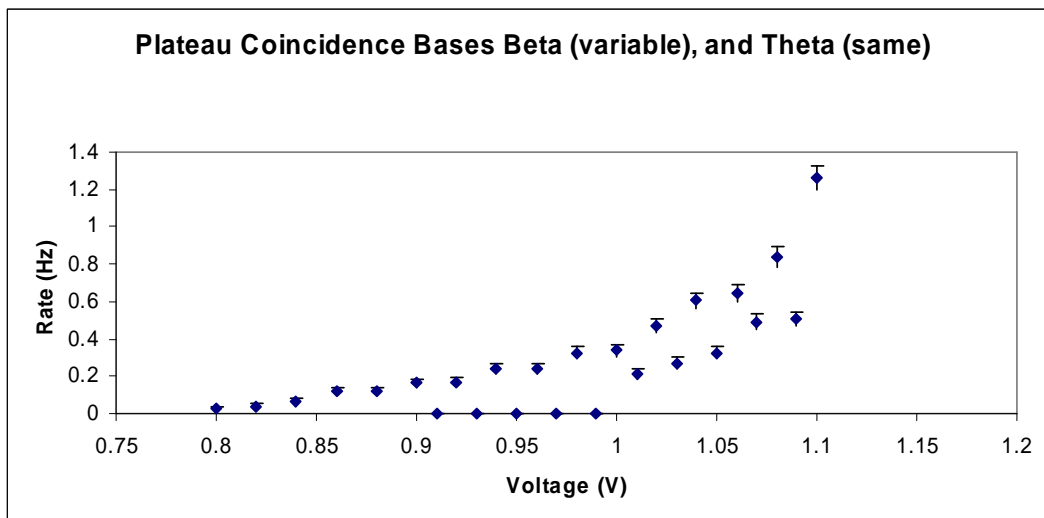
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**Beta Plateau:**



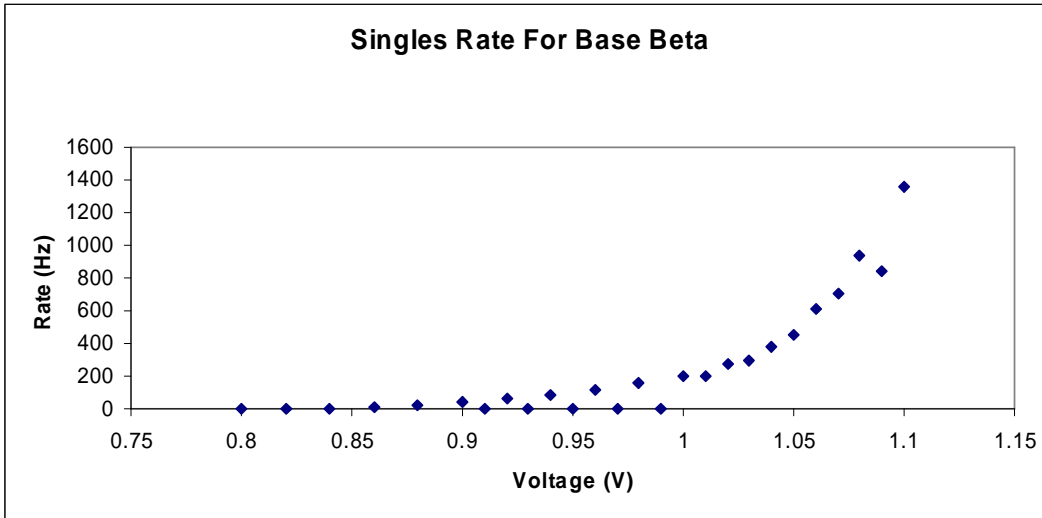
Coincidence:

The coincidence graph shows no clearly evident plateau. More points were taken between 1 volts and 1.1 volts to search for a plateau, but these were given up when it became clearly evident that the new points were drastically different. These points were taken the day after the preliminary plateau but they should not have been different.

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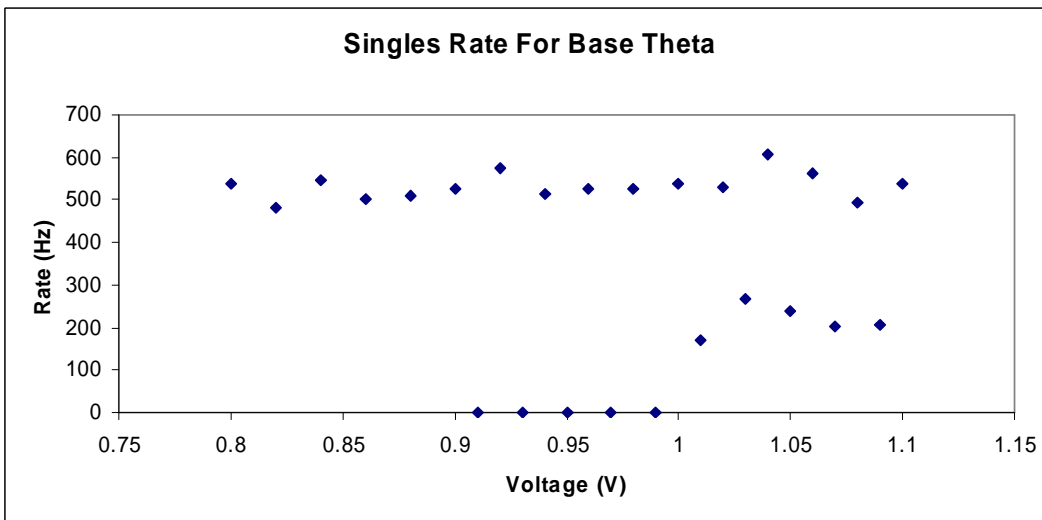
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Single Beta:

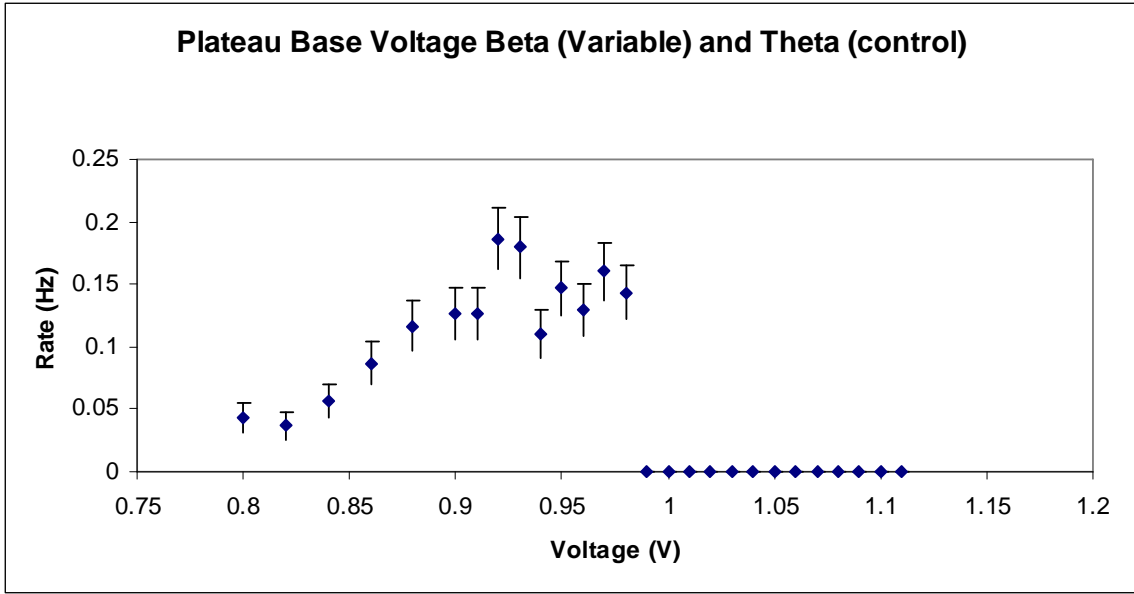
It looked like an exponential curve, as predicted. This singles rate, however, was not as smooth as predicted at 1.09 volts. This may be due to the fact that data was not taken all at once.



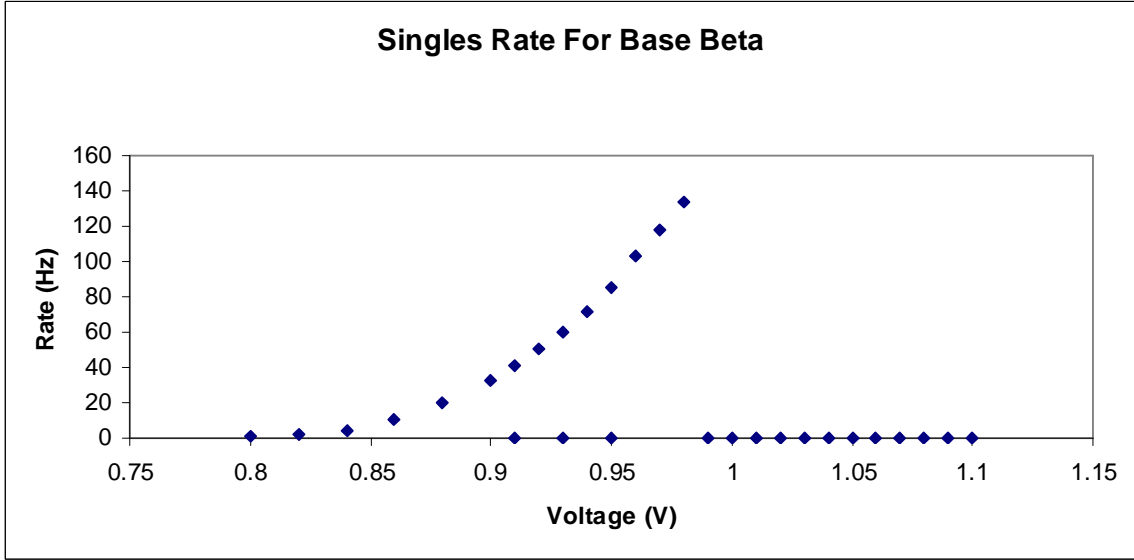
Single Theta:

Theta was supposed to be a straight line across the graph. The voltage was not changing, so the count rate should have stayed the same, too. The next day more points were taken between .9 volts and 1.1 volts, but the new trend seemed drastically different than the previous data. We are still unsure as to why the count rate for base Theta seems to change over long periods of time.

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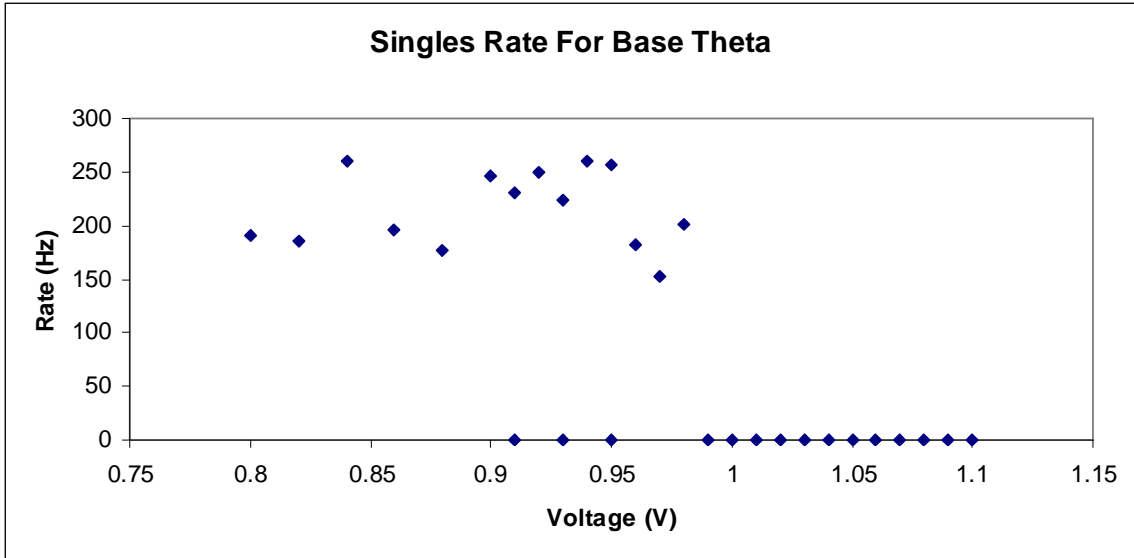


Coincidence (2):  
 This was the worst graph by far. There is no clear plateau whatsoever, and the points do not act at all as they should, so data was stopped after .97 volts. That brings up the question: Is this the fault of base Beta or Theta? If it is the fault of one, but not the other, why?



Singles Beta (2):  
 It is clear by this graph that the Irregularity in the coincidence rate is not due to Base Beta, because the curve is exponential, the way it should be. There are no dips or significant oddity to the Beta single's rate.

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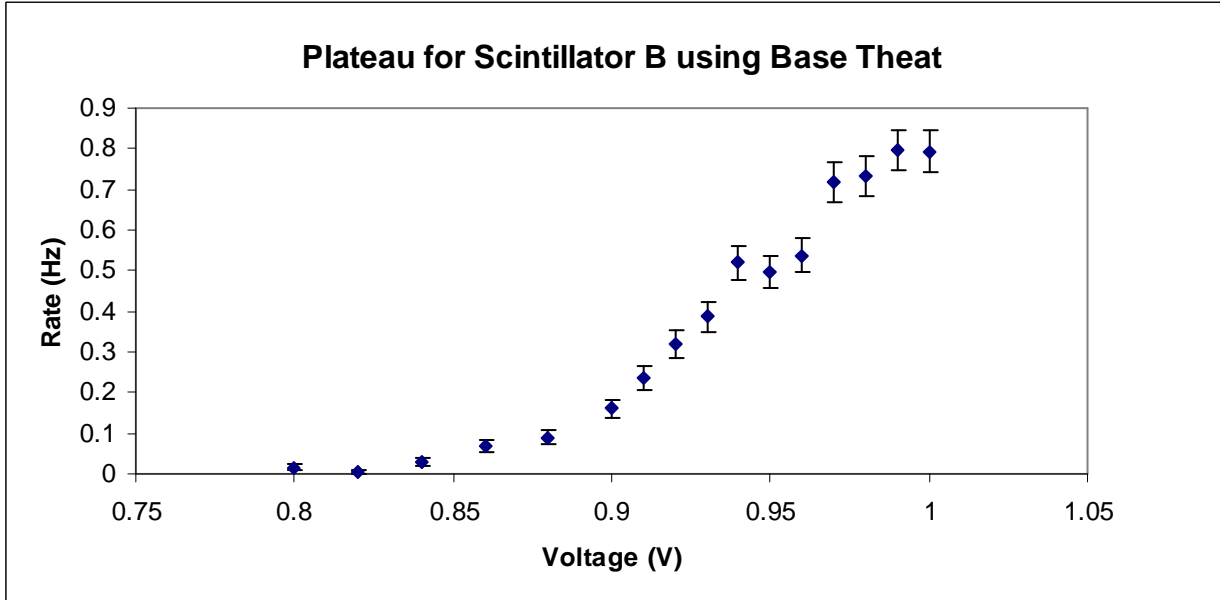


Singles for Theta (2):

The problem is isolated to Theta, because its graph should be a fairly straight line. The voltage in Theta was constant throughout the plateauing and the counts rates should be constant. Why would the count rate vary so significantly? The irregularities are not due to an environmental change, because Beta was exposed to the environment in the same way Theta was. It is safe to say that the problem is within the circuitry of Theta.

**Theta Plateau:**

Despite the problems with Theta, a plateau was attempted.



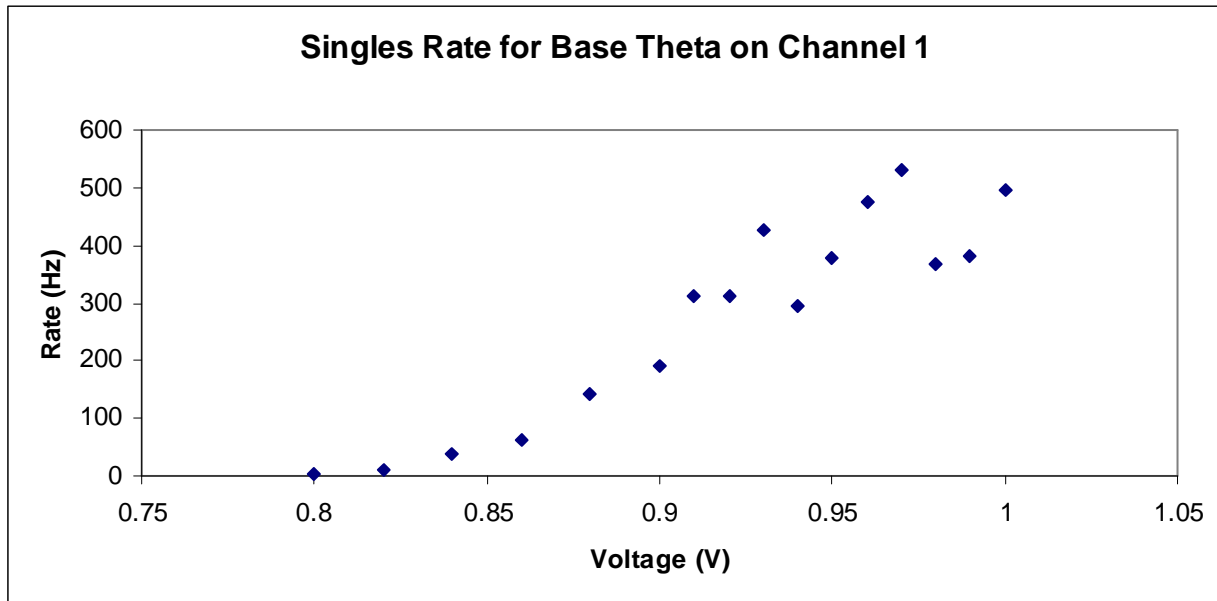
Coincidence:

At first glance this graph seems to indicate a plateau around .95 volts. More data should be taken around these points to insure that there is a plateau. This graph shows no

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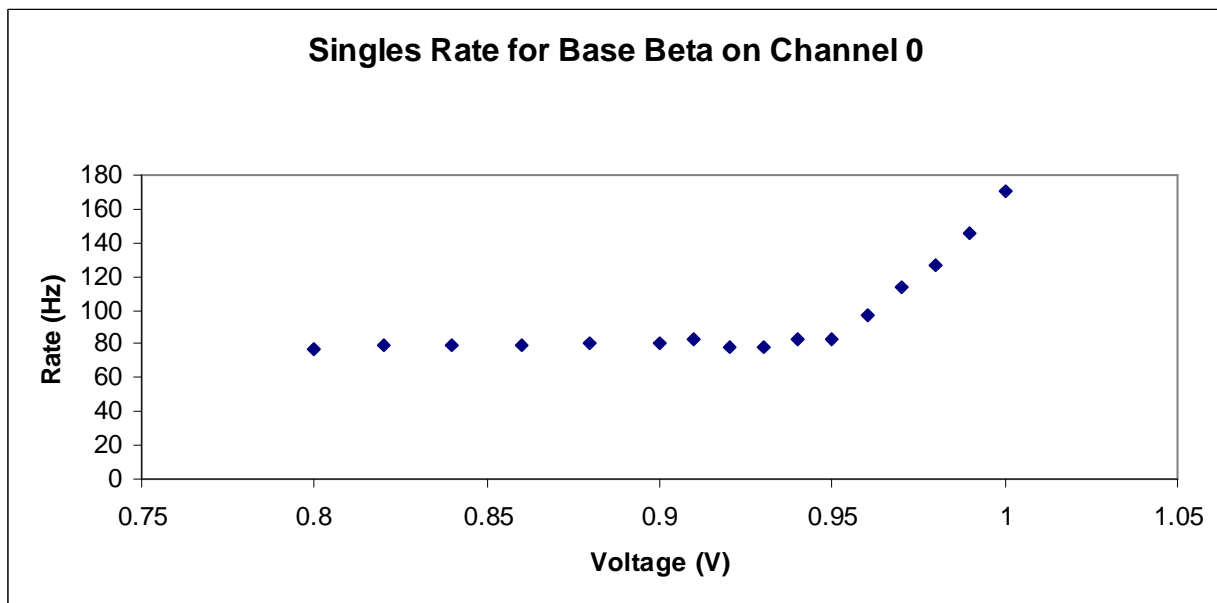


definite plateau, since the error bars are so large that a French curve could easily be placed through the points in an exponential curve.



#### Singles Theta:

Theta was the base whose voltage was being changed. In the past Theta has produced unreliable count rates for a constant voltage and it seems to be following in that vein now. After about .9 volts Theta shows a general upward trend but not the exponential expected.



#### Singles Beta:

The voltage for Beta remained constant and the count rate should also have been constant. After .95 volts, however, the count rate became greater. Since a problem like this had never before occurred with Beta and since no problems were found on examination of the base we were not able to find what caused such unexpected data. This change in count rates for Beta put the plateau graph under suspicion, though.

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### **Analysis:**

It would be wise to do the following:

- Not plateau in intervals
- Wait ten minutes before starting to plateau to give the bases time to warm up.
- Re-take data points if they seem irregular, because the point may have just been a particularly unusual one.
- Start taking data around .9~.95 volts.

None of the graphs taken show conclusive plateaus. We were unable to find an optimum voltage for any of our bases, but we'd had problems with the bases and the voltage regulator box before. We were unable to completely isolate the problem(s.)

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